GROUNDWATER INFORMATION SHEET

N-Nitrosodimethylamine (NDMA)

The purpose of this groundwater information sheet is to provide general information regarding a specific constituent of concern (COC). The following information is pulled from a variety of sources and data relates mainly to drinking water. For additional information, the reader is encouraged to consult the references cited at the end of the information sheet.

GENERAL INFORMATION	
Constituent of Concern	N-Nitrosodimethylamine (NDMA)
Aliases	Dimethylnitrosamine; N-Dimethylnitrosamine; DMNA; N-Methyl-N-nitrosomethanamine; N,N-Dimethylnitrosoamine; NDMA is one of the group of chemicals known as Nitrosamines
Chemical Formula	$(CH_3)_2N_2O$
CAS No.	62-75-9
Storet No.	34438
Summary	NDMA is an emerging drinking water contaminant that is of interest because of its miscibility with water, as well as its carcinogenicity and toxicity. The California Department of Public Health (CDPH) has established a notification level (NL) of 0.01 micrograms per liter (μg/L) for NDMA. Though used primarily in research, NDMA has been used in the production of liquid rocket fuel, and a variety of other industrial uses. NDMA has also been reported to be present in foods, beverages, drugs, and tobacco smoke and to be an air and water contaminant. According to CDPH data, 843 wells have been sampled for NDMA from 1984 to 2008. Since the establishment of a lower detection limit in 1998 (0.002 μg/L), 28 public drinking and agricultural water wells have had detections and in 13 wells, NDMA was equal or above the NL. Of those detections, 27 were in Los Angeles County.

REGULATORY AND WATER QUALITY LEVELS[1]		
Type	**Agency**	**Concentration**
Federal MCL	US EPA, Region 9	N/A
State MCL	CDPH	N/A
Notification Level	CDPH	0.01 µg/L
Response Level (removal the source from service)	CDPH	0.3 µg/L
Others: Public Health Goal (PHG)	OEHHA	0.003 µg/L

[1]These levels generally relate to drinking water, other water quality levels may exist. For further information, see A Compilation of Water Quality Goals (Marshack, 2008).

SUMMARY OF DETECTIONS IN PUBLIC DRINKING WATER WELLS[2]	
Detection Type	**Number of Groundwater Sources**
Number of active and standby public water wells[3] with concentration ≥ 0.01 µg/L (NL).	66 wells were tested since the NL was established (1998), 13 out of 28 wells with detections had NDMA ≥ 0.01 µg/L
County having public drinking water wells[3] with NDMA detections.	Los Angeles (27), Sacramento (1)

[2]Based on CDPH data collected from 1984-2008 (Geotracker). See Figure 1.
[3]In general, drinking water from active and standby wells is treated or blended so consumers are not exposed to water exceeding MCLs. Individual wells and wells for small water systems not regulated by CDPH are not included in these figures.

ANALYTICAL INFORMATION	
Analytical Test Methods	US EPA approved Method 521 for nitrosamines. For drinking water, EPA Method 521 uses solid phase extraction (SPE) and capillary column GC with large-volume injection and chemical ionization tandem MS (MS/MS) (Munch and Bassett 2004) A recently developed method using liquid chromatography tandem MS (LC/MS/MS) detects both thermally stable and unstable nitrosamines (Zhao et al 2006)
Method Detection Limit	0.00028 µg/L
Lowest Concentration Minimum Reporting Level	0.0016 µg/L
Known Limitations to	US EPA Method 521 should be performed by or under

Analytical Methods	supervision of analysts with experience in solid phase extraction and chemical ionization analyses. Certain aspects of collection, holding and preservation of samples, may influence NDMA analyses. Nitrosamines may be present in trace amount in rubber products so rubber components must be avoided in any sampling, storage and analytical devices. Sample must be stored in temperature below 10^0C during the first 48 hours, and stored in the lab under 6^0C before extraction, which must be done with 14 days after collection
Testing Requirements	Currently, NDMA is on the #2 list of unregulated contaminants for which monitoring is required (US EPA). All Public Water Systems (PWS) serving more than 100,000 people, 320 selected PWS serving 10,001 to 100,000 people, and 480 selected PWSs serving 10,000 or fewer people are required to conduct the Screening Survey (List 2) for 15 contaminants during a 12-month period during January 2008-December 2010. CDPH established a Notification Level of 0.01 µg/L in 1998.

NDMA OCCURRENCE	
Anthropogenic Sources	NDMA's use is primarily in research, but it was also used in the production of 1,1-dimethylhydrazine for liquid rocket fuel. Other industrial uses include: a nematocide, a plasticizer for rubber, in polymers and copolymers, a component of batteries, a solvent, an antioxidant, and a lubricant additive. NDMA was reported to be present in: a variety of foods, beverages and drugs; in tobacco smoke; it has been detected as an air pollutant; in treated industrial wastewater; treated sewage (in proximity to a 1,1-dimethylhydrazine manufacturing facility); deionized water (reportedly as result of deionization process); high nitrate well water; and chlorinated (by chloramine) drinking water (NTP, 2000)
Natural Sources	No known natural sources of NDMA.
History of Occurrence	In 1998, concern about NDMA contamination at a Sacramento County aerospace facility (Aerojet) prompted investigations in nearby drinking water sources. Samples collected in February and March 1998 from a drinking water well in eastern Sacramento County confirmed the presence of NDMA at approximately 0.15 µg/L. In southern California, NDMA was detected in three drinking water wells in the San Gabriel Basin that were sampled in May 1998. Two wells with NDMA at concentrations of 0.07µg/L

	were removed from service. The third well, already out of service because of trichloroethylene and perchlorate contamination, contained NDMA at 3 µg/L. In spring of 1999, as interest in NDMA monitoring increased in the water treatment community, CDPH (formerly Department of Health Services, DHS) was informed of NDMA findings in treated waste water. From the standpoint of protecting drinking water consumers and sources, CDPH considered this finding important in the evaluation of proposed recycled water projects involving wastewater discharges and groundwater recharge. In addition, in 1999, limited sampling indicated that NDMA appeared to be present at very low levels (<0.01 µg/L) in treated drinking water. Preliminary analyses suggested that NDMA's presence in drinking water was related to disinfection processes, but very limited data were available, and often they appeared to be inconclusive. In November 1999, CDPH initiated studies with drinking water utilities to investigate the occurrence of NDMA in raw, treated and distributed water, the role water quality and treatment processes may play in the production of NDMA, and the possible extent of NDMA production at various steps in the water treatment process. In April 2000, the American Water Works Association Research Foundation and the Water Environment Foundation released a Request for Proposal for the study of factors affecting the formation of NDMA in water and occurrence. In May 2000, two wells in Orange County had NDMA at concentrations of approximately 0.03 to 0.04 µg/L, and were taken out of service. A nearby groundwater recharge operation involving injection of treated wastewater contained NDMA in its injected water. CDPH informed the wastewater treatment plant that its activities were impairing groundwater, and directed them to reduce the levels of NDMA accordingly. In May 2000, a system in Los Angeles County found NDMA in its groundwater sources at concentrations of 0.032 to 0.076 µg/L, associated with chemicals formerly produced in the aerospace industry. In June 2000, a system in Los Angeles County found NDMA at about 0.03 µg/L, apparently related to resins used in water

	treatment for nitrate removal. In June 2000, also in Los Angeles County, NDMA at concentrations of 0.049 and 0.074 µg/L (duplicates) and 0.091 µg/L was found in treated wastewater that was blended for use as groundwater recharge.
Contaminant Transport Characteristics	Laboratory studies are currently being conducted to better understand how NDMA is formed and how it can be removed. NDMA has a high water solubility indicating that NDMA detected in groundwater is likely completely dissolved. Volatilization to air from water is expected because NDMA has a moderately high vapor pressure. NDMA's Henry's Law Constant is 2.63 E10-7 and organic carbon partition coefficient (log Koc) is 1.079. Because of low Koc, NDMA is expected to move with groundwater flow without being adsorbed to soil Initial research shows that NDMA can form through a reaction between monochloramine (a form of chlorine commonly found during disinfection) and simple amines, such as dimethylamine. Precursors of NDMA in recycled water are being identified to develop methods for conventional and advanced treatment.

REMEDIATION & TREATMENT TECHNOLOGIES

UV/Oxidation technology: Ultraviolet light technology has been used successfully for the destruction of NDMA to levels below drinking water standards. UV can be coupled with the use of hydrogen peroxide in an advanced oxidation system application for NDMA destruction. Recent studies have shown that aerobic and anaerobic biodegradation may be possible.

Pilot testing of a biological process that uses bacteria that can feed on propane to provide a co-metabolic reaction to break apart the NDMA. (Bradley and others, 2005, A. MacDonald, RWQCB-5, personal communication).

HEALTH EFFECT INFORMATION

NDMA causes cancer in laboratory animals such as /rats and mice when they are exposed at high levels over their lifetimes. Chemicals that cause cancer in laboratory animals also may increase the risk of cancer in people who are exposed over long periods of time.

NDMA is identified as a carcinogen under California's Health and Safety Code Section 25249.5, et seq., the Safe Drinking Water and Toxic Enforcement Act of 1986 ("Proposition 65"). In addition, the US EPA identifies NDMA as a "probable human carcinogen" (US EPA, 1997), and the National Toxicology Program lists NDMA as "reasonably anticipated to be a human carcinogen" (NTP, 2000).

KEY REFERENCES

1. Agency for Toxic Substances and Disease Registry. Public Health Assessment: Air Force Plant PJKS, Waterton, Jefferson County, Colorado. March 29, 2000. http://www.atsdr.cdc.gov/HAC/PHA/pjks/pjk_p4b.html#appd (Sept. 2002)

2. Bradley, P.M., S.A. Carr, R.B. Baird, and F.H. Chappelle. 2005. "Biodegradation of N-nitrosodimethylamine in soil from a water reclamation facility. " Bioremediation Journal. Vol.9. Pages 115-120.

3. California Department of Public Health. NDMA and Other Nitrosamines – Drinking Water Issues (December 2008), http://www.cdph.ca.gov/certlic/drinkingwater/Pages/NDMA.aspx

4. California Environmental Protection Agency / Regional Water Quality Control Board, Central Valley Region. July 2008. *A Compilation of Water Quality Goals*. Prepared by Jon B. Marshack. http://www.waterboards.ca.gov/centralvalley/water_issues/water_quality_standards_limits/water_quality_goals/wq_goals_2008.pdf

5. Munch, J.W. and M.V. Bassett. September 2004. "U.S. EPA Method 521: Determination of Nitrosoamines in Drinking Water by Solid Phase Extraction (SPE) and Capillary Column Gas Chromatography with Large Volume Injection and Chemical Ionization Tandem Mass Spectometry (MS/MS). " Version 1.0 National Exposure Research Laboratory, Cincinnati, Ohio. EPA 600-R-05-054.

6. National Toxicology Program (NTP), 2000, *"N-Nitrosodimethylamine CAS No. 62-75-9," Ninth Report on Carcinogens*, Public Health Service, US Department of Health and Human Services.

7. Online NIOSH Pocket Guide to Chemical Hazard. http://www.cdc.gov/niosh/npg/npgd0000.html (Sept. 2002)

8. U.S. Environmental Protection Agency, N-nitrosodimethylamine; CASRN 62-75-9**,** Integrated Risk Information Service (IRIS) Substance File. http://www.epa.gov/iris/subst/0045.htm (Sept. 2002)

9. U.S. Environmental Protection Agency, Emerging Contaminant - N – Nitroso-dimethylamine (NDMA) April 2008

10. Zhao, Y-Y., J. Boyd, S.E. Hrudey, and X-F. Li. 2006. "Characterization of New Nitrosoamines in Drinking Water Using Liquid Chromatography Tandem Mass Spectrometry." Environmental Science and Technology. Vol.40. Pages 7636-7641.

FOR MORE INFORMATION, CONTACT:
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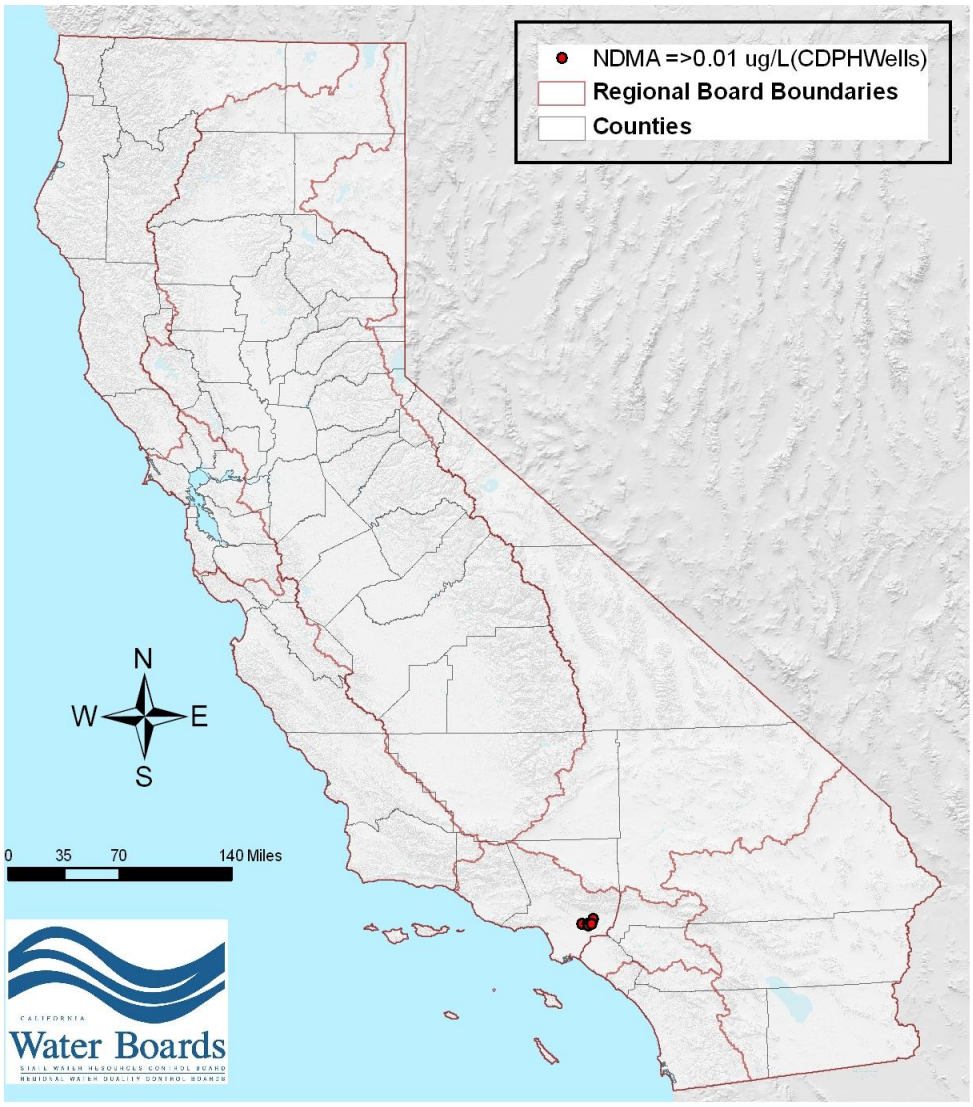

Active and Standby CDPH Wells with at Least One Detection of N-Nitrosodimethylamine (NDMA) =>0.01ug/L, CA-NL (13 wells)

Source: 1998-2008 CDPH Data (Rev. 03/15/09 by J. Stepek)

GEOTRACKER-GAMA